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# AGRICULTURAL Research

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CURRENT SERIAL RECORDS

THERE'S MORE YIELD PER ACRE IN WILD OATS  
Page 8

# AGRICULTURAL Research

November 1967/Vol. 16, No. 5

## Harvests for Tomorrow

A long time ago, rural school children sang a harvest song that began:

"Swing the shining sickle, cut the waving grain . . ."

This was a happy song, sung by the pupils who had returned to school after helping with the fall harvest. Soon Thanksgiving would be observed and the children would be singing songs appropriate to that holiday in thanks for a bountiful harvest.

These were the "good old days."

It's a long way from those "good old days" of back-breaking labor and uncertain yields to the ARS laboratories of today, where scientists are not only working to develop plants that will give higher yields on the farms of the future, but are striving to find better and cheaper harvesting methods as well as developing efficient biological control of insect pests.

The way has been long, taking scientists around the world in their search for new species of plants, especially grains, to cross with those already established.

The story of the wild oats species (p. 8) offers promise of a high-yield, high-protein grain, which will be available to farmers in the next decade.

President Johnson, in his January 10 State of the Union Message, said: "Next to the pursuit of peace, the really great challenge to the human family is the race between food supply and population increase. That race tonight is being lost."

Eleven months later we hopefully are gaining ground in that race, for high-yield, high protein grains are tailor-made for a world where much of the available space is going to be taken up by people.

American children of the 21st century, in the days of controlled environment and computerized farming, may not know what a sickle is—or a corn crib, for that matter—but they and children in other parts of the world will not know hunger either.

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# gravel mulches

## could stop groundwater decline

WHEN COLORADO CROPS need water, wheel-mounted sprinkler systems a quarter of a mile long begin trundling slowly over the fields, rotating around wells like the hands of giant clocks and carrying water to as much as 125 acres of land per sweep.

Sprinkler irrigation has made farming profitable in eastern Colorado and other semiarid portions of the midwest. Farmers, however, are pumping more water out of the ground than the 17-inch annual rainfall can restore, say W. D. Kemper and R. E. Danielson, ARS and Colorado State University soil scientists stationed at Fort Collins. If the loss continues, costly irrigation equipment will someday be worthless.

Mulches made of gravel may help solve the problem. The researchers say that a layer of sand or gravel spread on low-value land will catch precipitation, keep most of it from evaporating, and speed it down to the water table.

The researchers' experiments thus far are encouraging. They used soil columns 3 feet long and 6 inches in diameter to check the passage of water through various types of soil with various types of gravel mulch. Besides allowing for rapid infiltration, the mulches retained little capillary water to provide a path for upward flow.

By projecting their data to field conditions in Colorado, the scientists estimate that ten to twelve additional inches of rainfall per acre of mulch could be put in the water table through use of gravel mulches.

Some hitches remain, however. To be efficient, a gravel-mulched area would have to be kept weedfree, so that weeds wouldn't use up the water. Studies must be conducted to make sure the weed killers used don't contaminate the ground water.

Cost is another factor. Kemper said that research is now

underway at the University of Arizona on a machine that will extract gravel from gravelly soils and leave it on the surface. On soils averaging at least 20 percent gravel, the cost of the machine operation would be \$10 to \$20 per acre—not unreasonable, Kemper feels, in view of the yields that can be obtained with irrigation.

Gravel mulches would remove land from any other use. But water might be one of the most valuable products certain types of land could produce. In eastern Colorado, it takes about 15 acres of prairie to catch the rainfall needed to provide groundwater for one irrigated acre. If this ratio is not maintained, or if groundwater infiltration per acre is not increased, groundwater supplies will continue to decline. Because irrigated land is so much more productive than unirrigated, farmers might benefit from investing in recharge systems.

Gravel mulches are the most drastic of Kemper's and Danielson's efforts to increase groundwater supplies. Other possibilities receiving attention:

- Sagebrush eradication. This deep-rooted plant uses much water.
- Deep-plowing. Clay soils could be broken up to increase permeability and bring sand and gravel layers to the surface.
- Conservation terraces. Already proved valuable in erosion control, they may also be used for collecting water and promoting infiltration to the water table.
- Potholes. Water might be drained from them into the water table through wells, as has been done with the playa lakes of the Southern High Plains.

The Office of Water Resources Research of the U.S. Department of Interior is now cooperating with CSU and ARS on the groundwater recharge studies. ■

# USABLE WATER from Sewage Effluent?

**P**LANT-SOIL FILTERS may help convert sewage effluent into water that can be used by cities and farms.

Herman Bouwer, hydraulic engineer at the U.S. Water Conservation Laboratory in Phoenix, Ariz., designed the plant-soil filters—grass-covered basins—through which effluent from a sewage treatment plant is being channelled. The water is purified as it percolates through the grass and soil. Bouwer's research is part of a pilot project to determine whether the filters are practical on a large scale in Arizona.

The grass eliminates some of the filth and thus increases the rate at which the basins can accept water, Bouwer said. By acting as an obstruction, the grass also increases flow turbulence, thus hastening the replenishment of oxygen in the water. It also provides an anchoring place for aerobic bacteria that digest organic substances in the water.

Plant-soil filters are used in other countries, but to date have received little attention here. Sewage treatment plants can remove about 90 percent of the biodegradable material from sewage, but do not remove all of the

*Filter basin, below, is one of three used for comparison purposes. The others are planted to Bermudagrass. Effluent is pumped into beds at far end in measured amounts (PN-1557).*



*Effluent from sewage treatment plant flows through Arizona desert. Plant-soil filters may help provide good source of quality irrigation water (PN-1558).*

viruses and other microorganisms that might endanger health. Plant-soil filters should remove these organisms and provide a new source of good-quality irrigation water.

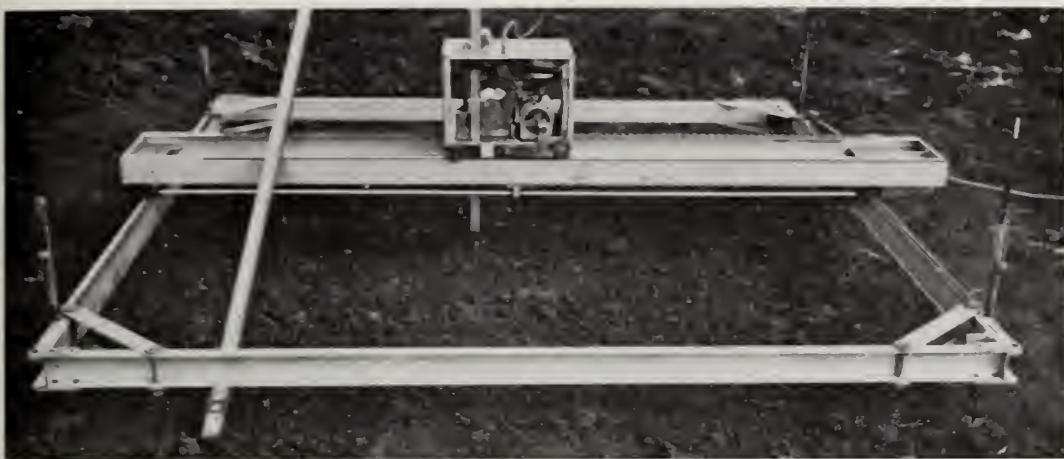
In addition, they can be used to recharge groundwater supplies in arid regions such as central Arizona, where the water table is plummeting at a rate of about 10 feet per year; and they can help reduce stream pollution in the humid East, either by cleaning sewage effluent before it reaches waterways, or by cleaning it and pumping it up as groundwater without ever discharging it into the waterways.

The filter project, dubbed "Flushing Meadows," consists of six 700-by-20-foot basins located in the dry Salt River bed west of Phoenix. Effluent from the Phoenix sewage plant flows nearby and is pumped into the basins in measured amounts.

Chief objectives of the project are to find out how much effluent can be put through the system and at what rate, how good the water is when it reaches the water table, and what types of soil and vegetation will do the best job of cleaning the water.

At present, three of the basins are planted to Bermudagrass and three are free of vegetation, for comparison purposes. The basins can be flooded separately or joined three at a time in serpentine fashion to test the effect of additional flow length. Samples of underground water are drawn from wells of varying depth. The soil beneath the experimental basins is almost entirely sand and gravel to a depth of at least 200 feet. The water table is about 25 feet deep.

Bouwer's research is being conducted in cooperation with the Salt River Project, central Arizona's irrigation district. Financial support for the project is being furnished by ARS, the Salt River Project, and the Federal Water Pollution Control Administration, U.S. Department of Interior. ■



*Profile meter consists of probing unit, top center, and motorized base. Both are mounted on aluminum frame. Instrument records measurements in inches (PN-1559).*

# SOIL SURFACE STUDIES

## ... now Automated

A NEWLY-DESIGNED recording unit has put the compilation and analysis of data obtained in soil surface studies on an automated basis.

Two agricultural engineers designed the recording unit by modifying a soil surface profile meter previously developed by ARS (AGR. RES., April 1965, p. 11).

Called a recording soil surface profile meter, the device is capable of measuring surface roughness and the volume change of soil in the field and of recording the data on computer cards, all in a matter of seconds. Such data help scientists to evaluate tillage tools and determine what tillage practices are best for certain crops on different types of soil.

Many soil conditions having a major influence on seedling emergence, plant development, and plant growth are difficult to measure in the field. In the past, several measuring instruments have been developed, but most require techniques that alter the soil and make it impossible to follow changes that later occur in the sample. Moreover, the instruments have not

always made accurate measurements and the data collected have to be manually read and recorded.

The new profile meter overcomes the disadvantage of previous techniques; it does not destroy the soil sample, is accurate, and completely

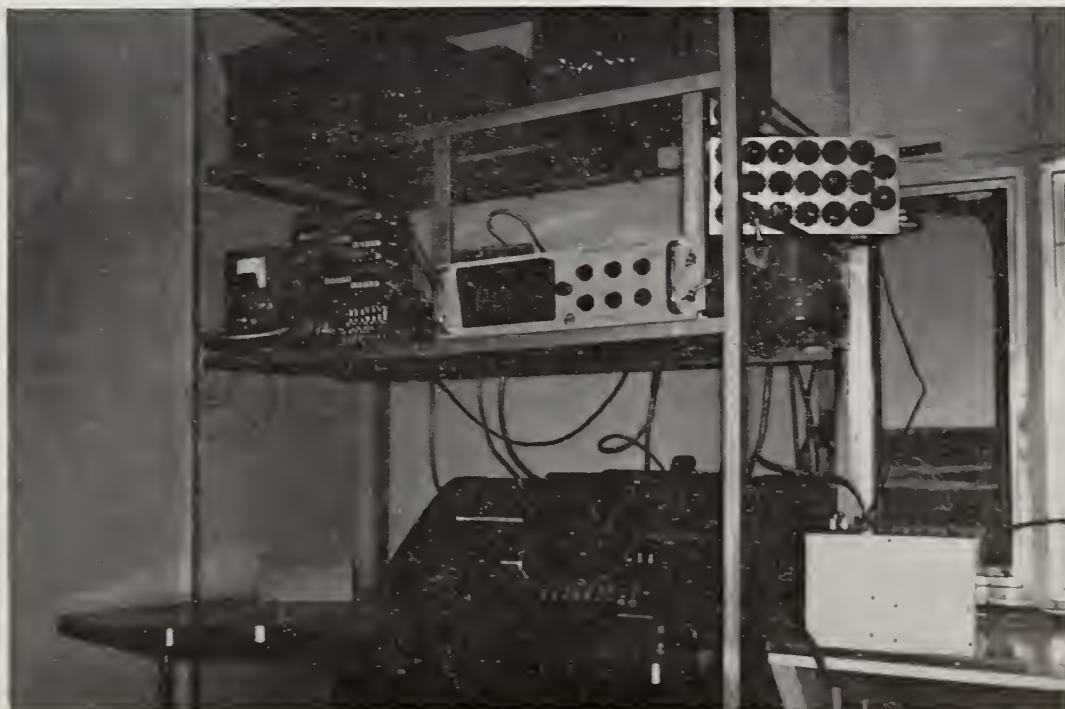
eliminates manual reading and recording of data. It takes only about 2 seconds to make and record a single prod measurement with the new device. In tests, 4,800 measurements were made in 4 hours, including the time required for two men to set up the device.

The probing unit consists of a motorized component that moves back and forth and left and right in 1-inch increments along an aluminum frame (see photo). At each increment the unit stops and a probe stem, driven downward, stops at the soil surface to make a measurement.

The measurement, in inches, is transmitted from the probing unit and directly recorded on punch cards. The recording instrumentation is mounted inside a converted trailer house which is air-conditioned to control temperature, humidity, and dust. The power for the system is furnished by a portable generator.

The device is being developed by ARS agricultural engineers H. D. Currence and W. G. Lovely in cooperation with the Iowa Agricultural Experiment Station at Ames. ■

*Instrumentation for automated recording of measurements on punch cards. Instruments are in air conditioned trailer to control temperature, humidity, and dust (PN-1560).*



## ZIG-ZAG CLOVER: can it grow in Mountain Pastures?

**Z**IGZAG CLOVER may be the solution to the problem of maintaining stands of forage clover in pastures along the backbone of the Rocky Mountains.

A very hardy perennial, zigzag (*Trifolium Medium L.*) spreads by sending out rhizomes, or underground stems, which sprout new shoots and roots each year. Its stems exhibit a zigzag pattern at nodes; thus its name.

Although its yield is smaller than that of alfalfa and other clovers now in common use, it lives longer with less care. It also holds the soil to prevent erosion. Grown together with other legumes and grasses, it serves as a stopgap after the other legumes have died out and before the pasture is reseeded.

Scientists at Colorado State University, Fort Collins, studied the effects

of three harvest times on zigzag clover. ARS research geneticist C. E. Townsend, agronomists A. D. Dotzenko and K. R. Storer of CSU, and programmer-statistician F. E. Edlin, also of CSU, studied 10 genotypes (clones) or varieties, which ranged from low pasture types, less than 7 inches tall, to tall plants suitable for hay. In the experiments, only one plant died out of 1,440 transplanted from greenhouses to open fields.

The plants were harvested twice in each of two growing seasons. One plot of each variety was harvested in late spring before flowering and again in early August; a second plot just as flowering began and again in early September; and a third when the plants were in full bloom and again in mid-September. About 2 inches of plant was left standing after harvest.

Tall clovers outyielded short, bushy

varieties, particularly when they were harvested after they were in bloom. They also spread faster. Early harvest produced higher protein, especially in the bushy plants. Varieties of intermediate height usually flowered earliest, permitting early harvest. Plants harvested before flowering during the first growing season flowered much earlier the next season than those harvested after the blossoms had opened.

The main hurdle to be cleared before zigzag clover reaches the market is its poor seed yield. Canadian researchers found that selections in a field usually produce few or no seeds; they may have spread from a single plant and will not cross pollinate. Zigzag clover requires cross pollination to produce seed. Only selections which originated in different environments can be intercrossed. ■

## SALT RESISTANT GRAPES for higher yields

**C**HLORIDE INJURY to grape vines can be prevented by grafting vines to roots that resist uptake of chloride.

This finding should substantially improve grape yields in irrigated areas of the western United States and in other arid-zone countries such as Israel and Australia.

Chloride is one of several salts found in most irrigated soil. Once it enters the plant's system, it accumulates in the leaves, causes leaf burn, and eventually kills the plant. Researchers have known for some time, however, that certain varieties of roots resist entry of salt.

Leon Bernstein, plant physiologist at the U.S. Salinity Laboratory in Riverside, Calif., selected three grape rootstocks known to be superior for many soil conditions and tested them for response to chloride salts. The

three varieties—Salt Creek, Dog Ridge, and #1613—all proved resistant to chloride.

Onto these salt-resistant roots Bernstein grafted two popular varieties of table grape—Cardinal and Thompson Seedless. All combinations of vine and root produced salt-resistant plants. Cardinal grapes grafted to Salt Creek roots, for example, took up only one-fifteenth as much chloride as ungrafted Cardinal grapes.

The principle of grafting has been used by horticulturists for centuries to adapt plants for certain soils or climates. Few efforts have been made to graft plants specifically for saline soil, however. The saline soil problem is mostly a byproduct of irrigation agriculture; salts are carried to the soil in irrigation water and accumulate in the soil as plants transpire water. Thus salinity does not at-

tract attention until a field has been undergoing irrigation for some time.

About 5 percent of the California grape crop is affected by salt damage, Bernstein estimates. In the Coachella Valley, where high-value table grapes are grown, about 20 percent of the multi-million dollar crop is damaged annually by salt. Here, introduction of salt-resistant rootstocks will be of immediate economic significance.

Bernstein's studies were done in 10-ton sandbeds, 6 feet wide, 10 feet long, and 6 feet deep. The plants were grown under very nearly normal conditions, and the results of the study can be readily applied to field situations.

Plant scientists hope to find out why some root varieties absorb so much more salt than others, and what mechanism regulates this response. ■



## new corn shelling unit shows promise... **"HUGS and SQUEEZES"** ears

**A** NEW CORN SHELLING unit that prevents kernel damage during harvesting is being tested on the new corn crop by ARS agricultural engineers in Iowa.

The new unit has thick rubber belts that "hug" the ears and "softly squeeze" off the kernels. Soft squeezing, the engineers hope, will eliminate damage to the kernels, reducing subsequent attacks from molds and other organisms. Cracks in the skin of the

kernels provide open doors for organisms to enter the seed, lowering the quality of the stored grain, and speeding spoilage and deterioration.

Corn is, perhaps, the Nation's most valuable crop. In addition to such industrial products as starch, dextran, and alcohol, it is one of the most important grain crops for animal and poultry feeding. It is a major human food, as evidenced by the large consumption of sweet corn, cereal, sirup,

and canned corn. Corn consistently ranks high as a cash crop. For example, in 1965 it ranked second only to cotton in providing cash returns to farmers.

Since World War II, farmers have harvested increasing percentages of their crop as shelled corn—mainly because it is easier to handle than ear corn. This year, almost half the commercial crop will be shelled in the field by mechanical shellers that remove the kernels by force of impact. Engineers estimate that such machines damage 30 percent or more of the kernels. When the kernels are damaged, the rate of biological activity increases. As a result, stored corn spoils faster, and corn that is destined for foreign markets loses quality more rapidly, lowering the market price of the shipments.

The experimental corn-shelling unit is expected to reduce damage by 90 to 100 percent. It was designed by ARS engineers R. A. Saul and W. V. Hukill in cooperation with the Iowa Agricultural Experiment Station at Ames; it is being tested on freshly picked corn for the first time during the 1967 harvest.

Key components of the new shelling unit are dual rubber belts and "floating" springs. The rubber belts, turning in opposite directions, roll the ears of corn through the unit and at the same time shell the ears with an intensifying squeezing action.

The floating springs automatically adjust the sheller to the diameter of the ears of corn as they pass between the two rubber belts.

In laboratory tests with the new unit, corn with 15-percent moisture was shelled with no apparent damage to the kernels. If the unit proves as successful on fresh corn of 20- to 30-percent moisture—the range of moisture percentage at which most farmers harvest their corn crops—the principle will be incorporated in mechanical cornpickers. ■



# OATS:

## MOST PROTEIN PER ACRE?

*Cover photo: Dr. H. C. Murphy, leader of ARS oats investigations, comparing United States' highest protein commercial variety, Garland, with wild oats from Israel. Garland is at top, wild species at bottom (PN-2701-2).*

SCIENTISTS ARE WORKING with a wild oat species to develop varieties of oats that may outstrip all other grains in per-acre production of protein.

Collections of the wild oat species, *Avena sterilis*, which crosses readily with our cultivated varieties, contain outstanding sources of high protein, high kernel weight, and better disease

resistance. Scientists are working to breed these good traits into commercial varieties.

The wild oat collections were originally made in Israel for ARS under a Public Law 480 project to find sources of resistance to crown rust. Collections were later made in other Mediterranean region countries by a Canadian-Welsh expedition.

About the same time the wild oats began arriving for disease-resistance testing, ARS started a screening program at Beltsville, Md., and several State experiment stations to find higher protein grains to meet the needs of humans and livestock throughout the world. The wild species were included in the screening program. To everyone's surprise,





*Far left photo: Wild oat, left, and cultivated oat, right. Wild oats have 30 percent protein, cultivated oats have 19. Center photo: Emasculating wild oat so it can be crossed with cultivated oats. Above: Roger T. Smith, ARS technician, inspects wild oats which have been bagged to increase seed yield. Unbagged plants in foreground are Garland variety, used as a check (BN-30205; ST-2701-5; PN-1565).*

tains 25 percent protein, total protein per acre should exceed that of any crop now being produced. Oat yields in the United States average about 50 bushels per acre, but yields of 100-130 bushels are not uncommon in the major producing States.

In the several thousands of *A. sterilis* collections now on hand, scientists have found a wealth of outstanding resistance to all known races of crown rust, along with resistance to stem rust, barley yellow dwarf virus, soil-borne mosaic virus, powdery mildew, and smut.

In nature, wild oats shatters its seed before it matures. This makes it impossible to harvest the crop, but scientists have found that the trait can be bred out by crossing with our cultivated species.

Seeds from the most promising wild oat collections have been sent to oat breeders at State experiment stations throughout the country to

start the breeding program. Scientists may run into some unforeseen problems in breeding from wild to cultivated oats, but results of limited breeding look promising.

In about 2 years, the progenies from the crosses will be analyzed to tell if they are retaining the high protein content. ARS scientists expect there will be at least 15,000 samples a year for total protein analysis and at least 500 samples for complete amino acid determination.

The scientists point out that it will take 8 to 10 years of breeding and testing before the first new varieties of high protein oats will be available for commercial production.

Already established as having the highest protein content and best balanced protein of any cereal grain now produced, oats could become one of our most valuable foods—an encouraging prospect for mankind in a crowded world.■

some of the collections showed as much as 30 percent protein content as compared with 18 to 19 percent for the best U.S. varieties, plus the same good amino acid balance.

Some of the wild oat species produce very large kernels. If this trait can be transferred it could raise oat yields considerably. If a future variety yields 150 bushels per acre and con-

*Left photo: Demonstration farmer and his crop of hybrid maize. Two-thirds of Kenya's 300,000 acres of hybrid maize are grown by small farmers. Right photo: Sign in Swahili invites farmers to see for themselves "the new type of maize." "Mali" on bag, means wealth (PN-1562; PN-1563).*

# KENYA MAIZE



# IMPROVEMENT . . .

*example of cooperation*

**T**HOSE WHO BELIEVE that farmers in developing countries will not or cannot adopt new methods of plant husbandry should take a look at the maize- or corn-improvement program in East Africa's Kenya.

Farmers in Kenya's best corn-growing locations — high-altitude areas with long wet seasons—are making the changeover from open-pollinated varieties to locally adapted hybrids as rapidly as Corn Belt farmers made the changeover when hybrids first became available in the United States.

When hybrid maize seed was first offered for sale to Kenyan farmers in 1963, they planted about 400 acres. From 1963 to 1966 increase in hybrid maize acreage kept pace with seed availability; farmers took all there was. In 1967, for the first time, there was seed for all who wanted it, and an estimated 300,000 acres were

planted to hybrid maize, 200,000 of which are grown by small farmers. In areas where the hybrids are adapted, they are planted on about 25 percent of the maize acreage.

The Kenya maize improvement program is a combination of research and extension. Program sponsors include the Kenya Government, Great Britain's Ministry of Overseas Development, the Rockefeller Foundation, the U.S. State Department's Agency for International Development, and ARS.

The program was initiated in 1958. U.S. participation began in 1963, and ARS has been represented in Kenya by geneticist S. A. Eberhart. ARS research agronomist G. F. Sprague, Beltsville, Md., who is the project leader in the United States, spends about 1 month every year in Africa.

When the program began, little information was available on the effects

of various cultural and management practices on yield. Extensive experiments were conducted involving all factors thought to be of importance. These included time of planting, plant population, type of maize, and standard of weeding and fertilization. Of these, time of planting and type of maize had the greatest influence on yield, followed in order by plant populations, weed control, and fertilization.

Development of hybrids began with the inbreeding of a hardy local variety, Kenya Flat White. But although a double-cross hybrid development from these inbred lines had increased production 25 percent by 1963, it was obvious that a lack of genetic diversity was limiting progress.

To solve this problem, strains from the United States and South and Central America were brought to Kenya

for testing. Most of these strains were worthless, but in the large assortment of germ plasm, scientists found what they were looking for. And by 1966, Hybrid 611B (Kitale III X Equador 573—an exotic high-altitude type) was yielding 71.40 bushels per acre as compared to 12.56 bushels per acre before the maize program began.

Progress by technicians, however, is only half the story; progress by the farmers is the other half. Seed and fertilizers cost money, and in developing countries farmers tend to follow agricultural practices that have been handed down for generations. They are skeptical of good yields obtained on government stations, which, they point out, have money and machinery.

A field extension program by the Kenya Ministry of Agriculture sparked the changeover. To get maize growers to use hybrid seed—and to plant with fertilizer at the right time and generally follow a high level of culture—thousands of demonstration plots were established on small holdings where people could see the results.

The farmers on whose land these plots are located were selected with great care. Cooperators had to be men who could command local respect, but not men whose prestige was based on wealth or politics.

The native demonstration farmers bought their own seed and fertilizer and followed the recommended cultural practices. In return, agricultural advisers were on hand at all stages to advise them. This became a magnificent program of “show and tell.”

Cooperating farmers themselves did the demonstrations. At harvest time the neighbors were invited to see the results. The high yields on the sample sites were ample proof of success and an example of what could be done by farmers like themselves, who had no more resources than they. ■

## PRE-CUT METHOD SAVES VALUABLE PLANTING TIME

**W**HAT DOES a northern potato farmer do while waiting out the last blasts of winter? He could be cutting and treating seed potatoes for the big planting rush still 2 months away.

A research project carried out last winter at the Potato Handling Research Center, Presque Isle, Maine, indicates that seed potatoes can be cut, treated, cured, and stored for as long as 2 months before planting.

ARS plant pathologist J. B. Wilson and Maine Agricultural Experiment Station engineer J. H. Hunter developed the precut method because of the rapidly increasing demand for labor during the hectic planting season.

Wilson and Hunter made tests with certified Kennebec and Russet Burbank varieties. The scientists cut the potatoes and treated the pieces with a fungicide dust. They piled the pieces 6 feet deep in bins 10 feet wide, and 8 feet long with a concrete center channel 2 feet wide by 1 foot deep for a mechanical bin unloader and air duct.

Bins were cleaned, disinfected, and the walls lined with polyethylene film to help hold the moisture. About 42,500 pounds of potatoes were cut and put in each bin within 5 days while curing conditions were maintained. That is, temperatures were held at about 60° F. and relative humidity of 90 percent or more was maintained by adding moisture to the air with pneumatic spray nozzles. Portable fans circulated the

air through the piles of precut potatoes.

The scientists maintained this curing condition for 3 more days. Then they cooled the potatoes to between 40° and 42° F. and operated the circulating fans 25 percent of the time for 1 week. The fans were then cut back to operate on a 10-percent duty cycle for the remaining 8 weeks of storage to hold drying to a minimum.

Several days before bringing the potatoes out of storage, the temperature was raised to between 46° and 50°, and the fans were operated 50 percent of the time. This conditioned the potatoes for handling and stimulated sprouting.

Seed pieces sampled as they came out of storage were in excellent condition with no sign of soft rot or shriveling. The traditional problem of cut pieces sticking together did not occur, partly because of the fungicide dust treatment.

The test results show that pre-cut seed potatoes can be stored in bulk piles at least 6 feet deep—if the potatoes are disease-free, and strict sanitary measures and proper curing procedures are followed.

Chemically treated and properly cured seed pieces grow into better stands than fresh-cut seed when field temperature and moisture conditions are poor, Wilson said. Earlier research has shown that properly healed seed pieces act just like a whole seed potato in preventing invasion by disease-causing bacteria and fungi. ■

# *Scientists Offer Recommendations for Winter Wheat Fertilizing*

---

**W**HAT IS THE MAJOR EFFECT of nitrogen and phosphorus on the growth of winter wheat? More tiller and head production, say ARS and State researchers at Bozeman, Mont.

P. L. Brown, ARS soil scientist, and C. M. Smith, extension agronomist, Montana State U., are attempting to provide Montana and other Northern Plains States farmers with specific, comprehensive recommendations for fertilizing winter wheat.

For the increased yields that come from increased tiller and head production, Brown and Smith recommend fertilizing with nitrogen and phosphorus in the fall and again with nitrogen in the spring.

In a field test near Belgrade, Mont., the scientists fertilized winter wheat in the fall with 11 pounds of nitrogen and 21 pounds of phosphorus per acre. In the spring they added another 30 pounds of nitrogen.

Most plants on the fertilized plot produced five large heads; plants on an unfertilized check plot averaged three heads. Projecting to harvest, Brown and Smith said the fertilized plot might yield up to 50 bushels per acre compared to 30 bushels per acre for the check plot.

The researchers emphasize that phosphorus is most effective when drilled into the soil at planting time. Nitrogen is more mobile and can be top dressed; it moves into the soil with rainfall or melting snow.

Water supply for the crop is critical. In the Northern Plains, winter wheat needs 8 to 12 inches of water from initiation of spring growth to harvest to produce a good crop. This water comes from stored moisture and precipitation. The less water available, the poorer the response to nitrogen and phosphorus fertilizers.

Growing wheat in arid or semiarid

States is something of a plant nutrient "mining" operation. Wheat takes nutrients from the soil that are not replaced by the usual practice of returning straw to the soil.

A large percentage of nutrients absorbed by the crop is in the grain at harvest. In a crop that yields 40 bushels per acre, each acre of wheat will have about 50 pounds of nitrogen in the kernels and 20 pounds in the straw. If the straw is put back, the soil still lacks about 30 pounds of nitrogen per acre.

It's the same with phosphorus. Forty bushels of wheat contain about 11 pounds of phosphorus in the kernels while the straw contains only 2 pounds. The resulting loss: 9 pounds.

How much nitrogen and phosphorous fertilizer should a farmer use on winter wheat? Brown and Smith say, "Only enough to make up the difference between that available in the soil and the amount necessary to produce the expected yield."

For example, each bushel of wheat requires about 2 pounds of nitrogen. If a farmer expects a yield of, say, 30 bushels per acre, and there is only 10 pounds of nitrogen per acre available in the soil, he should add 50 pounds of nitrogen in the spring.

Fertilizer needs should be determined by soil analysis each year because soils do not always contribute the same amount of nutrients. As it decomposes, organic matter in the soil releases nitrogen. Cultivation speeds decomposition, so continued cropping reduces the available nitrogen.

While organic matter releases some phosphorus in soil, the bulk of it is released by minerals. Continued cropping uses phosphorus faster than it can be replaced by minerals. Consequently, an increasing part of crop needs is being supplied by fertilizer; future needs may be as high as 50 percent.■

**S**WINE RESEARCHERS are analyzing protein in sow milk, a study that may one day lead to new methods for selecting superior breeding stock.

ARS physiologists R. R. Kraeling and R. J. Gerrits have discovered two distinct types of protein variations in both the casein (curd) and the whey of sow milk. They have studied the occurrence of each of these protein types in the Duroc and Yorkshire herds at Beltsville, Md.

Protein types are identified by passing droplets of milk through a polyacrylamide gel under electrical traction. The electrical force pulls each protein fraction to a characteristic zone in the gel strip, where it can be identified as a dark band when the gel is stained blue.

The bands consist of two distinguishable sections, showing that one fraction of whey or casein, called "A," settles out ahead of another, named "B."

In addition to separating the protein types in gels, scientists have distinguished them chemically. This was done by an extraction procedure worked out by ARS chemist E. B. Kalan of the Eastern utilization research laboratory, Philadelphia, Pa. He found that the two whey types in

# SOW MILK ANALYSIS

## ... May Lead to Better HOGS

sow milk crystallize as white needles, quite similar to each other in molecular structure. They differ by two amino acid constituents—alanine and valine.

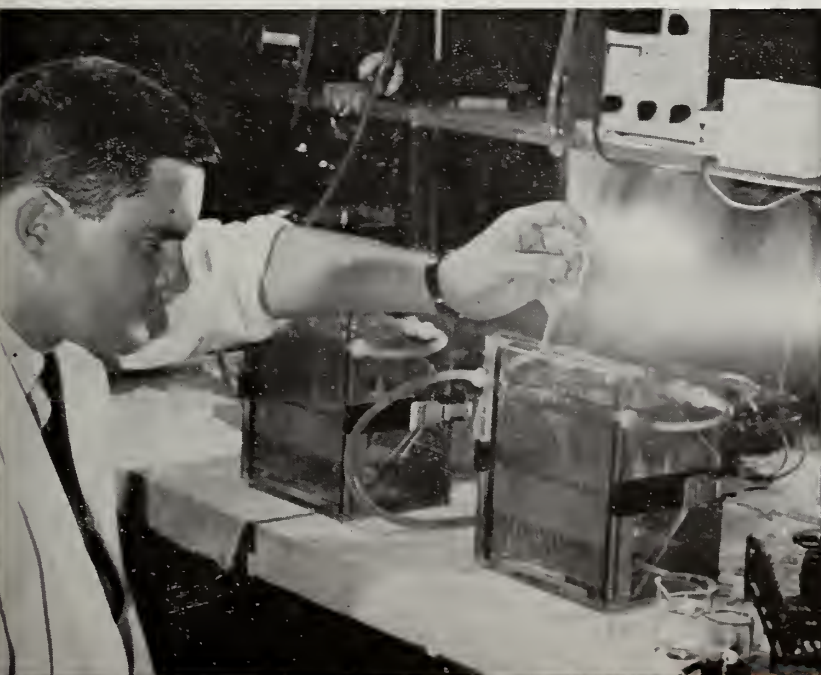
Casein and whey protein types are determined by single pairs of genes, making them convenient traits for genetic studies. Durocs and Yorkshires differ somewhat in the prevalence of whey types. About 95 percent of the Durocs studied showed evidence of carrying a gene for the A type of whey, compared to only 25 percent of the Yorkshires. The frequency of A and B types of casein is more nearly equal in the two breeds studied. About 28 percent of the Durocs and 22 percent of the Yorkshires carried the A gene for casein. The researchers say these findings are preliminary and will have to be substantiated in future work.

As these studies progress, genetic

clues stemming from analysis of sow milk may some day enable swine breeders to select sows that produce more or better milk for feeding their young. Similar studies conducted on cow milk for the past 28 years have led to the recognition of 13 separate types of milk caseins and 6 types of whey. More advanced studies of protein types in cattle indicate that a certain form of whey protein may be associated with a higher cow milk yield. Similar associations may exist for sows.

For swine breeding in general, protein types are also important because, like blood types, they help identify an animal. Furthermore, it might become possible for protein types to serve as genetic markers (AGR. RES., February 1957, p. 6) that help breeders find the best boar-sow matings to produce the most desirable offspring. ■

*Left photo: ARS physiologist R. R. Kraeling injects drops of sow milk into an electrophoresis machine that separates the sample into various protein fractions used for genetic studies. Right photo: Kraeling and his assistant, Curtis Barber, are among the few people who milk sows routinely. Only a few squirts of milk (5 to 10 cc.) need be taken from a sow weighing 200 to 400 pounds (ST-2605-2; ST-2607-10).*





Wasp thrusts egg-laying organ through bark to deposit egg beside a larva of elm bark beetle. Wasp egg hatches into larva and devours pest (BN-30352).



Tiny larva of wasp develops on larva of elm bark beetle, sucking its body juices, eventually killing the beetle larva (BN-30354).

## Tiny Wasp May Curtail

# DUTCH ELM DISEASE

**D**UTCH ELM DISEASE may be curtailed by a tiny wasp that kills the disease carrier.

The wasp, *Dendrosoter protuberans*, attacks a disease-bearing beetle that burrows into the bark of elm trees. The female *Dendrosoter* wasp locates hidden beetle larvae in the bark, thrusting her stinger—actually an egg-laying organ—through the bark, depositing eggs beside the beetle larvae.

When the eggs hatch into wasp larvae, they attack the beetle larvae, killing them by sucking their body juices. Adult wasps increase the tempo of the attack by producing three generations for each generation of beetles.

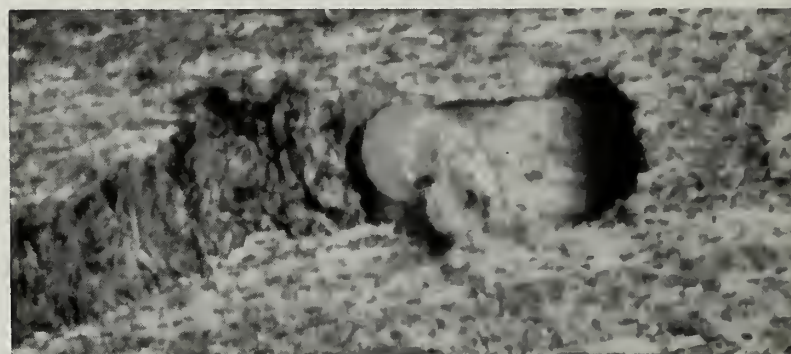
Entomologist R. I. Sailer, former head of ARS' European Parasite Laboratory, near Paris, now Chief of the Insect Identification and Parasite Introduction Branch, Beltsville, Md., collected the wasp in France. After he determined that the wasp attacks only the European elm bark beetle, Sailer had more than 3,000 of the wasps imported to the United States for further

observation and testing.

Releases of the wasps by entomologists of USDA's Forest Service, in Ohio and Missouri, indicate that the parasites will seek out the beetle larvae under the environmental conditions in those States; more extensive releases are being made by cooperators in Michigan with equally promising results.

Scientists are now rearing the wasps by the millions at several laboratories, including the Northeastern Forest Experiment Station Laboratory, Delaware, Ohio, for research and mass release in infested areas. Although the wasps are not expected to eradicate the beetles (this would result in starvation of the wasps), they could become a major weapon in the battle to end the epidemic threat of Dutch elm disease.

Not only do the European elm bark beetles carry the fungus disease spores from tree to tree, they obligingly shelter spores in special organs, *mycangia*, during flights and provide places for them to germinate. The



Wasp larva, although still smaller than its host, has now almost completely devoured the bark beetle larva (BN-30355).

beetles bore 2-inch tunnels in diseased and weakened trees in which they lay their eggs. The fungus spores develop in the tunnels if the tree is diseased. When the beetles emerge from the tunnels as adults, they carry spores with them to new, healthy trees, depositing them into the vessels that carry sap through the wood. The fungus growth blocks the flow of sap. The tree begins to wilt and may die within 2 years.

Although the wasps cannot save trees that are already under attack by beetles and the fungus, they can help prevent further spread of the elm's enemies. The wasp kills up to 70 percent of the beetle larvae in Europe, which is one reason Dutch elm disease is not as serious a problem there. The beetle, like many of our insect pests, is native to Europe, where several natural enemies help keep it in check. Scientists are studying some of these insect enemies in addition to *D. protuberans*, to determine their potential usefulness in the United States. ■

A SEX ATTRACTANT that someday may lure the fall armyworm to its death has been produced artificially by ARS chemists and entomologists at Tifton, Ga., and Beltsville, Md.

The fall armyworm attacks a wide range of crops, including corn, cotton, peanuts, cabbage, alfalfa, grasses, and other cultivated and wild plants.

The potential for sex attractants in killing insects has long been known, but the fall armyworm is only the sixth insect from which scientists have succeeded in isolating the natural attractant, identifying its chemical structure, and producing a synthetic lure. The other insects are the cabbage looper, gypsy moth, pink bollworm, silkworm, and wax moth.

Biochemist A. A. Sekul and entomologist A. N. Sparks, Tifton, first isolated, identified, and synthesized the armyworm's sex attractant, Cis-9-tetradecen-1-ol acetate, a compound resembling many that occur naturally in certain edible fats and oils. The scientists needed 135,000 female armyworm moths to obtain sufficient natural lure to identify it chemically. During this phase of their experiments, they determined that the moth produces this attractant in the last abdominal segment. Scientists are now searching for the specific source of the attractant—a gland or perhaps a body process.

Soon after the Tifton scientists produced the synthetic lure, Beltsville

chemist J. D. Warthen, Jr., developed a less expensive 3-day, four-step process.

Each insect species produces an attractant that affects only its own kind. The sex lures of the cabbage looper and fall armyworm are similar. ARS chemist Martin Jacobson and science aid Charles Harding, Beltsville, developed a 5-day, seven-step process that converts the cabbage looper moth's sex lure into that of the fall armyworm.

A medicine dropper barely wet with synthetic lure affected male moths the same as a female moth giving off the natural lure. The males exhibited their typical mating behavior when the bulb of the dropper was squeezed to force out lure-laden air around them. They did not respond to the attractant beyond distances of a few feet, however.

One way the attractant might be used against the fall armyworm would be to spread it across fields in pellets; the odor given off would mask the female's natural lure. Confused males would be attracted to the pellets instead of to females, reducing future generations of the pests because the mateless females would lay infertile eggs.

Sex attractants may someday be employed in traps in which males would starve to death or be killed by an insecticide. Scientists caution, however, that synthetic sex attractants have not yet been proved as adequate controls for this or any other insect. Field tests are necessary to fully gauge the lure's limitations and potentials.

The Georgia Coastal Plain Experiment Station, Tifton, cooperated in the research. ■

*Male fall armyworm moth responds to synthetic lure. Medicine dropper is barely wet with lure; males responded from distances of only a few feet (PN-1564).*

## SEX ATTRACTANT for FALL ARMYWORM (Produced Artificially)



## AGRISEARCH NOTES

### Bee Research Lab Dedicated

A new ARS Bee Research Laboratory near Tucson, Ariz., will be dedicated November 9.

Containing the most advanced equipment and research facilities for 50 scientists and supporting staff, the laboratory is located on a 5-acre tract provided by the University of Arizona, about 5 miles from the main campus.

Ways to make bees better pollinators and to make plants more attractive to bees as well as related goals will be studied by scientists who represent several agricultural disciplines.

Other areas of research will include behavior, nutrition, and food-using processes of honeybees, to fill gaps in the knowledge of how these factors influence bee activities and their usefulness to man.

Effects of pesticides, bee diseases, and other environmental conditions that affect a colony's life will also be studied. Equipment and materials used for hives and for handling the bees, honey, and wax will be tested by agricultural engineers.

Crops valued at between \$2 to \$3 billion depend on bees for pollination. An additional \$50 million crop of honey and wax is produced annually by bees in the United States.

### Revitalizing Spoil Piles

Scientists are making encouraging progress in low-cost reclamation of land wasted by kaolinite mining in central Georgia.

Kaolinite is a versatile industrial clay. One of its uses is coating book and magazine paper so that photographs print well. Only high-grade kaolinite is usable for this purpose, however, and the low-grade clay is left on the land in large piles called spoil.

Sides of the spoil piles are often too steep to hold seed and fertilizer. In addition, the spoil has a pH range of 4.8 to 5.4. In such acidic clay, appreciable amounts of aluminum are soluble which can make the soil toxic to plants. Toxic concentrations of zinc and manganese may also be present.

Scientists are now developing a two-step process for revitalizing the land to make it agriculturally productive. First, the spoil is partially leveled; then, deficiencies in plant nutrients are corrected. The scientists added 1 ton of lime per acre in order to change the pH to a desirable level. They found that adding 70 pounds of phosphorous and 100 pounds of potassium per acre will raise the spoil's nutrient level enough to establish growth of legumes.

"We can reclaim most of the spoil area for \$120 per acre, or less," says ARS soil scientist C. L. Parks of the

Southern Piedmont Soil Conservation Research Center, Watkinsville, Ga.

It will require about 3 years to evaluate the research, but results to date have been encouraging. "We think," Parks says, "that we can condition this spoil for any use a farmer might want to put it to—reforesting for pulpwood, grazing livestock, producing row crops, even truck farming." In each case, the lime and fertilizer requirements will depend on the crop and production goal; what will determine the future use of the land will be the amount of money that the farmer—and mining companies—will want to spend on leveling the piles.

Collaborating with Parks on the work are Fred Brackin of Soil Conservation Service, and H. F. Perkins and J. T. May of Georgia Agricultural Experiment Station, Athens.

**CAUTION:** In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly



careful where there is danger to wildlife or possible contamination of water supplies.